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## DESCRIPTION

## AUTOMATIC MACHINE CONTROL DEVICE

## Technical Field

[0001]

The present invention relates to an automatic machine control device that specifies a subject automatic machine when a brake of a driving shaft having the brake is released by worker's operation.

## Related Art

[0002]

An automatic machine, such as a rotary jig, a tilting jig, an industrial robot, or the like, which includes a motor, has a brake in order to keep its position against gravity when driving power of the motor is cut off. The brake is an exciting release type. The brake is effective for security because the brake stops the automatic machine in a short coast distance even though driving power of the motor is cut off due to power failure or the like during the operation of the automatic machine.

In a production system having a plurality of

automatic machines, an automatic machine or an automatic machine control device breaks down during operation, the broken automatic machine or automatic machine control device stops within a working area of another automatic machine. At this time, the automatic machine detects a breakdown or abnormality due to the breakdown and stops operation, and the automatic machine holds the motor by cutting off brake driving power. The stop automatic machine interrupts operations of other automatic machines, and thus it may be impossible to continue production. In addition, in order to analyze or restore the broken automatic machine or automatic machine control device, the automatic machine needs to be moved to a predetermined position. The automatic machine is moved to the predetermined position when the brake is released according to worker's operation.

[0003]

In known brake releasing, in order to release a brake of an individual shaft driving motor of a robot, a brake release operating switch is provided at a robot arm (Patent Document 1). Alternatively, a device that releases the brake is provided on a manipulator side to be separated from a path for

releasing the brake of the motor when the robot is driven, and a commercial-use power supply is connected to the device when the brake is released, and the brake is released by switch operation (Patent Document 2). In addition, a brake releasing device that, if necessary, releases the brake by changing the connection to the brake, is provided (Patent Document 3).

[0004]

As such, in a known robot control device or automatic machine control device, when a position or a posture of a robot main body or an automatic machine main body is manually changed, a brake releasing operation is performed or a brake releasing device is mounted on the robot main body or the automatic machine main body, or provides.

[0005]

Patent Document 1: Japanese Patent No. 2823079

Patent Document 2: JP-A-2001-269884

Patent Document 3: JP-A-6-304886

#### Disclosure of the Invention

##### Problem that the Invention is to solve

[0006]

In the known automatic machine (or robot)

having the motor, in Patent Documents 1 to 3, in order to release the brake, a worker needs to operate an operating switch that is provided on or in the vicinity of the automatic machine main body. Further, according to Patent Document 2, the commercial-use power supply needs to be connected to the brake releasing device. In addition, according to Patent Document 3, the brake releasing device needs to be provided on the automatic machine. However, in a working system, to which the automatic machine is applied, since there are many apparatuses, such as jigs, cables, pipes, and the like, around the automatic machine, an access to the automatic machine main body, or an access for connecting the commercial-use power supply or mounting the brake releasing device may be not easy. Moreover, when the worker needs to go up on the apparatuses so as to perform a job, the worker can be endangered because the job is performed in an unsafe place. Accordingly, a method that moves an installation place of the operating switch to a place where the operating switch can be easily operated has been used.

[0007]

In a production system having a plurality of

automatic machines disposed to be close to one another, if the installation place of the brake releasing switch is distant from the automatic machine, as the above-described method, the correspondence of the automatic machine to the brake releasing switch to be operated may not be obtained. Therefore, an erroneous operation that a brake of another automatic machine, not a subject automatic machine having a brake to be released, is released instead of may occur. The erroneous operation means that a brake of an automatic machine not intended by the worker is released. Because of the erroneous operation, a mechanism part of the automatic machine drops due to gravity to thereby damage or distort the automatic machine main body, the jig, or the workpiece. In addition, the worker around the automatic machine can be endangered.

For example, as proposed in JP-A-8-194511, one control device that can achieve an effective job by operating a plurality of automatic machines has the same problem.

[0008]

An object of the invention is to provide an automatic machine control device that can prevent

an erroneous operation, remove an excessive loss due to the erroneous operation, and care worker's safety by indicating that a brake is ready to be released, on an automatic machine main body having a brake to be released or in the vicinity of the automatic machine main body.

#### Means for Solving the Problem

[0009]

In order to solve the above-described problems, the invention has the following configuration.

According to a first aspect of the invention, there is provided with an automatic machine control device, which controls at least one automatic machine having a motor or a brake for holding a driving shaft connected to the motor, the automatic machine control device including: a brake releasing unit that releases the brake when the motor is not driven; and a brake release indication unit that is provided on the automatic machine or in the vicinity of the automatic machine, wherein the brake release indication unit indicates that the brake is ready to be released by the brake releasing unit.

[0010]

According to a second aspect of the invention, there is provided with the automatic machine control device according to the first aspect, the automatic machine has a driving power indication unit for indicating that the motor is driven, and the driving power indication unit serves as the brake release indication unit when the motor is not driven, and selects one state of different indication states, such as when the motor is driven or when the brake is to be released.

[0011]

According to a third aspect of the invention, there is provided with the automatic machine control device according to the first aspect, wherein the automatic machine is a robot, and the automatic machine control device is a robot control device.

#### Advantage of the Invention

[0012]

According to the first aspect of the invention, when brake releasing is selected by the worker, the fact is indicated so as to prevent an erroneous operation of a worker. This is particularly effective when the automatic machines are densely

disposed.

According to the second aspect of the invention, a driving power input lamp provided in the automatic machine is also used to indicate that brake releasing is selected. Since the indication states are changed for identification, the brake release indication unit does not need to be separately provided.

According to the third aspect of the invention, the invention is applied to the robot. In case of a vertical multi-joint robot, a robot arm is likely to drop by gravity due to unexpected brake releasing. Therefore, according to the third aspect of the invention, a great erroneous operation prevention effect is obtained. In particular, a great erroneous operation prevention effect can be obtained in a working system having a plurality of robots densely disposed.

#### Brief Description of the Drawings

[0013]

Fig. 1 is a brake releasing circuit diagram showing a first embodiment of the invention.

Fig. 2 is a brake releasing circuit diagram showing a second embodiment of the invention.

Fig. 3 is a flicker circuit diagram that is applied to the second embodiment of the invention.

Description of Reference Numerals and Signs

[0014]

- 1: POWER SUPPLY
- 2: CIRCUIT BREAKER
- 3: CONTROL POWER SUPPLY UNIT
- 4: CONTROL POWER RELAY
- 10: BRAKE POWER SUPPLY UNIT
- 11, 41, 51: INTERLOCK CONTACT
- 12, 42: FIRST CONTACT
- 13, 16, 19, 22: RECTIFIER
- 14, 44: FIRST BRAKE
- 15, 45: SECOND CONTACT
- 17, 47: SECOND BRAKE
- 18: THIRD CONTACT
- 20: THIRD BRAKE
- 21: FOURTH CONTACT
- 23: FOURTH BRAKE
- 24: RELEASING BRAKE POWER SUPPLY UNIT
- 25: RELEASE SELECTION CONTACT
- 26, 62: FIRST RELEASE CONTACT
- 27, 29, 31, 33: RECTIFIER
- 28, 64: SECOND RELEASE CONTACT

30: THIRD RELEASE CONTACT  
32: FOURTH RELEASE CONTACT  
34, 49, 59: LAMP  
40: FIRST AUTOMATIC MACHINE  
43, 46, 48: RECTIFIER  
50: SECOND AUTOMATIC MACHINE  
53, 58: RECTIFIER  
61: FIRST AUTOMATIC-MACHINE BRAKE RELEASE  
SELECTION CONTACT  
63, 65, 67: RECTIFIER  
66, 76: FLICKER CIRCUIT  
71: SECOND AUTOMATIC-MACHINE BRAKE RELEASE  
SELECTION CONTACT  
73, 75, 77: RECTIFIER  
T0, T1: TIME-LIMIT OPERATION AND INSTANTANEOUS  
RETURN TYPE RELAY

## Best Mode for Carrying Out the Invention

[0015]

Preferred embodiments of the invention will now be described with reference to the drawings.

## Embodiment 1

[0016]

Fig. 1 is a brake circuit diagram of an automatic machine control device according to the

invention. Fig. 1 shows main parts of the invention. Reference numeral 10 denotes a brake power supply unit for releasing a brake when a motor of an automatic machine is driven. Reference numeral 11 denotes an interlock contact. For example, an auxiliary contact of an electromagnetic contactor, which is used for inputting and cutting off driving power to the motor, is used as the interlock contact 11. An individual brake circuit, which releases the brake, branches off from the interlock contact 11. A first contact 12, a rectifier 13, and a first brake 14 form a first individual brake circuit. Similarly, a second contact 15, a rectifier 16, and a second brake 17 form a second individual brake circuit. A third contact 18, a rectifier 19, and a third brake 17 form a third individual brake circuit. A fourth contact 21, a rectifier 22, and a fourth brake 23 form a fourth individual brake circuit. Meanwhile, a member that attenuates a surge voltage generated when a brake current is cut off is not shown. The interlock contact 11 is provided to cut off the supply of releasing power to the brakes, even though the contacts 12, 15, 18, and 21 for individually releasing the brakes are fused and

bonded.

[0017]

Reference numeral 24 denotes a releasing brake power supply unit for releasing the brakes by worker's operation when the motors of the automatic machine are not driven. A release selection contact 25 serves as the main part when the brakes are released by the worker's operation. The release selection contact 25 may be a contact of a switch or a contact of a relay. The release selection contact 25 is connected to the first brake 14 through a first release contact 26 and a rectifier 27. Similarly, the release selection contact 25 is connected to the second brake 17 through a second release contact 28 and a rectifier 29. Further, the release selection contact 25 is connected to the third brake 20 through a third release contact 30 and a rectifier 31. In addition, the release selection contact 25 is connected to the fourth brake 23 through a fourth release contact 32 and a rectifier 33. Moreover, the release selection contact 25 is connected to a lamp 34. The lamp 34 is mounted on the automatic machine or is provided in the vicinity of the automatic machine. The lamp 34 may be a flicker or

a rotating pilot lamp.

Each of the first release contact 26, the second release contact 28, the third release contact 30, and the fourth release contact 32 may be a contact of a switch or a contact of a relay. The contacts 25, 26, 28, 30, and 32 are closed by pressing an operating switch for a brake releasing operation.

[0018]

In order for the worker to release the brakes when the motors are not driven, according to this embodiment, the brake power supply unit 10 and the releasing brake power supply unit 24 are supplied with power exclusively to each other from a power supply 1. That is, in a state where the motors are driven, a circuit breaker 2 is closed such that power is supplied to the brake power supply unit 10 and a control power supply unit 3 from the power supply 1. At this time, since a control power relay 4 is energized and excited, a normally closed contact is opened, and power is not supplied to the releasing brake power supply unit 24. Even if driving of the motor stops due to emergency stop, the power supply to the brake power supply unit 10 and the control power supply unit 3 continues.

Therefore, it may be impossible for the worker to perform the operation of releasing the brakes. When the circuit breaker 2 is opened, power is not supplied to the brake power supply unit 10 and the control power supply unit 3. Therefore, the control power relay is un-energized and the normally closed contact is closed, such that power is supplied to the releasing brake power supply unit 24.

[0019]

When the automatic machine, the motor of which is driven, operates, first, the circuit breaker 2 is closed, and power is supplied to the control power supply unit 3 and the brake power supply unit 10. At this time, the control power relay 4 is energized and excited, and the contact is opened. Therefore, power is not supplied to the releasing brake power supply 24. If the motor is driven, power is supplied to a motor driving device (not shown). At this time, the electromagnetic contactor is used when power is supplied, and the interlock contact 11, which uses the auxiliary contact of the electromagnetic contactor, is closed. Further, driving power is supplied to the motors so as to generate a desired torque. Then, the first

contact 12, the second contact 15, the third contact 18, and the fourth contact 21 are closed at almost the same time, such that power for unlocking the brakes is supplied to the first brake 14, the second brake 17, the third brake 20, and the fourth brake 23 from the brake power supply unit 10. As a result, the brakes are unlocked. Meanwhile, each of the rectifiers 13, 16, 19, and 22 prevents a backflow of brake unlocking power.

When driving of the motor stops, the first contact 12, the second contact 15, the third contact 18, and the fourth contact 21 are opened at almost the same time, and power to a driving power supply of the motor is cut off to thereby stop the supply of the driving power to the motor. At this time, the interlock contact 11 is opened.

[0020]

When the automatic machine does not operate, the circuit breaker 2 is in an open state, power is not supplied to the control power supply unit 3, and control power is not generated. Therefore, the control power relay 4 is un-energized and the normally closed contact is closed, such that power is supplied to the releasing brake power supply unit 24.

When the release selection contact 25 is closed by the worker's operation, the lamp 34 connected thereto lights. The lamp 34 performs brake release indication, and indicates that the brakes of the automatic machine subject to brake releasing are ready to be released.

In a state where the release selection contact 25 is closed by the worker's operation, when the first release contact 26, for example, is closed, a brake releasing current flows from the releasing brake power supply unit 24 to the release selection contact 25, the first release contact 26, the rectifier 27, and the first brake 14, such that the first brake 14 is released. Similarly, when the second release contact 28, the third release contact 30, and the fourth release contact 32 are closed, the second brake 17, the third brake 20, and the fourth brake 23 are released, respectively.

[0021]

In a production system having a plurality of automatic machines disposed thereon, according to the above-described brake releasing indication, it is possible for the worker to identify which automatic machine has the brakes to be released. When the lamp 34 is the flicker or the rotating

pilot lamp, it is more likely to attract worker's attention, and thus an erroneous operation can be markedly prevented.

The invention is different from Patent Documents 1 to 3 in that, since an operation around the automatic machine subject to brake releasing is excluded, the brake releasing indication is provided on a subject automatic machine or in the vicinity of the subject automatic machine, such that the subject automatic machine can be easily identified.

#### Embodiment 2

[0022]

Fig. 2 is a diagram showing the configuration of a second embodiment. In this embodiment, two automatic machines are controlled by one control device. Moreover, parts related to this embodiment are mainly shown in the drawing. The same parts as those in Fig. 1 are represented by the same reference numerals, and the descriptions of some parts will be omitted. Reference numerals 40 and 50 denote a first automatic machine and a second automatic machine, respectively. Reference numeral 41 denotes an interlock contact of the first automatic machine. The interlock contact 41

includes at least two poles. One pole of the interlock contact is connected to a first brake 44 through a first contact 42 and a rectifier 43, and also is connected to second brakes 47-1 and 47-2 through a second contact 45 and a rectifier 46. The other pole of the interlock contact supplies power from a control power supply unit 3 to a lamp 49 through a rectifier 48. The brakes 44, 47-1, and 47-2 are included in the first automatic machine. When driving power of motors of the first automatic machine is input, the interlock contact 41, which is an auxiliary contact, is closed, control power is supplied to the lamp 49, and the lamp 49 lights. Lighting of the lamp indicates that the motor is driven. Immediately after the motor generates a torque, the first contact 42 and the second contact 45 are closed, and brake power is supplied to the brakes 44, 47-1, and 47-2, such that the brakes are released.

The same is applied to a second automatic machine having brakes 54 and 57, and a lamp 59, and thus the description thereof will be omitted.

[0023]

Reference numeral 61 denotes a brake release selection contact of the first automatic machine,

and reference numeral 71 denotes a brake release selection contact of the second automatic machine. When the automatic machine does not operate, for example, when the brake release selection contact 61 of the first automatic machine is closed, and then a first release contact 62 is closed, power is supplied from a releasing brake power supply unit 24 to the first brake 44 through the first release contact 62 and a rectifier 63. Similarly, when a second release contact 64 is closed, power is supplied to the second brakes 47-1 and 47-2 through a second release contact 64 and a rectifier 65. A flicker circuit 66 is connected in parallel with a power supply circuit to the brakes. An output of the flicker circuit 66 is connected to the lamp 49 through a rectifier 67.

A brake releasing circuit of the second automatic machine from the brake releasing contact 71 is the same as the brake releasing circuit of the first automatic machine, and thus the description thereof will be omitted.

[0024]

Fig. 3 shows flicker circuits 66 and 76 shown in Fig. 2. In the drawing, T0 and T1 represent time-limit operation and instantaneous return type

relays (that is, on-delay timers, and hereinafter, simply referred to as timer). T0a and T0a1 represent normally opened contacts of the timer T0, and T1b represents a normally closed contact of the timer T1. FLP and FLN represent power supplies to this circuit.. When the brake release selection contacts 61 and 71 in Fig. 2 are closed, a voltage is supplied through both ends.

[0025]

The operation of the flicker circuit will now be described.

(1) In a state where power is not supplied to the power supplies FLP and FLN, the timer T0 and the timer T1 are not excited. Here, the contacts T0a and T0a1 of the timer T0 are opened and the contact T1b of the timer T1 is closed.

(2) When power is supplied to the power supplies FLP and FLN, the timer T0 is energized because the contact T1b is closed. Since the timer T0 is the time-limit operation type timer, the contacts T0a and T0a1 keep in open states until a predetermined time passes.

(3) When the predetermined time set in the timer T0 passes, the contact T0a of the Timer T0 is closed, and the timer T1 is energized. Since the

contact T1b of the timer T1 is the time-limit operation type timer, the contact T1b is not opened until the predetermined time passes. Therefore, the conduction state of the timer T0 is continued, and the contact T0a keeps in the closed state.

(4) If a predetermined time set in the timer T1 passes, the contact T1b of the timer T1 is opened. Since the timer T0 connected to the contact T1b is the instantaneous return type timer, the contact T0a of the timer T0 is opened. Since the timer T1 connected to the T0a is also the instantaneous return type, the contact T1b is closed and is in the state (2).

(5) The states (2), (3), and (4) are repeated until power is not supplied to the power supplies FLP and FLN. The contact T0a of the timer T0 is opened during the predetermined time set in the timer T0 and then is closed during the predetermined time set in the timer T1. The contact T0a1 operates at the same timing as the contact T0a, in the same phase and is disconnected from the relay of the power FLP.

[0026]

The outputs of the flicker circuits 66 and 76 are connected to the lamps 49 and 59 through the

rectifiers 67 and 77, respectively. Therefore, when the brake release selection contacts 61 and 71 are closed, the lamps 49 and 59 flicker. Moreover, when the brake release selection contacts 61 and 71 are closed, and the brakes are released by the worker, power is not supplied to the control power supply unit 3 because the circuit breaker 2 is opened.

Flickering cycles of the lamps can be changed by changing the predetermined time set in the timers T0 and T1. In addition, lighting and flickering of the lamps may be implemented by a CPU or other electronic parts.

In this embodiment, two indication states, that is, lighting and flickering, are indicated by one lamp. Alternatively, when the two states may be indicated in different colors, the worker can easily identify the two states.

[0027]

As such, when the motors are driven by closing the circuit breaker 2 that usually operates in the automatic machine, the lamps 49 and 59 are in normally lighting states. When the brakes are released by the worker's operation in a state where the automatic machine does not operate, if the

brake release selection contacts 61 or 71 is closed, the lamp 49 or 59 of the closed brake release selection contact 61 or 71 flickers. Therefore, the worker can clearly identify the automatic machine that has brakes to be released, and an erroneous operation that brakes of another automatic machine are released can be prevented.

#### Industrial Applicability

[0028]

When brakes of an automatic machine are released by worker's operation, since it is possible to specify a subject automatic machine, an automatic machine control device can be applied to a numerical control machine tool, a robot, a positioner, or the like, which has brakes.